Hot Fuel-Gas Sorbent System

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Introduction

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- U.S. has 25% of world's coal reserves.
- Coal accounts for nearly 56% of U.S. electric power generation.

Electricity generation from coal is going to play an increasingly important role in solving the Nation's future energy needs.

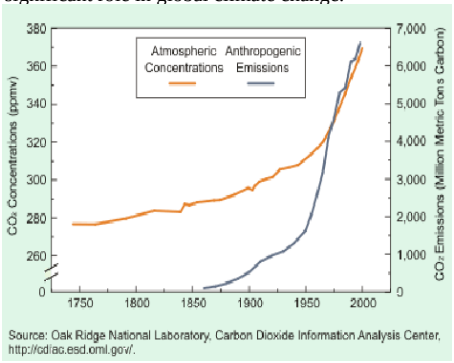
Pollution from Coal Based Power Plants

Coal based power plants contribute approximately

- 2/3rd of the country's sulfur dioxide (SO_2) emissions,
- 1/5th of the nitrogen oxides (NOx) emissions,
- over 1/3rd of the mercury emissions and
- 36% of U.S. carbon dioxide (CO_2) emissions.

CO_2 Emissions

CO_2 is a major greenhouse gas and plays a significant role in global climate change.



Source: Oak Ridge National Laboratory, Carbon Dioxide Information Analysis Center, http://cdiac.esd.ornl.gov/.

TDA's Approach

Integrated Gasification Combined Cycle (IGCC)

- IGCC is an Advanced power generation cycle
- Likely to replace conventional pulverized-coal combustion plants in new construction
- Has higher efficiency and lower emissions.

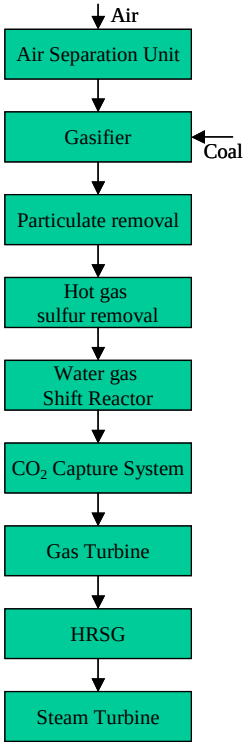
CO_2 Capture for IGCC power plants

- Future regulations may require the minimization or elimination of carbon dioxide emissions
- After combustion in gas turbine the flue gas is diluted by 10:1 and is at low-pressure
- CO_2 should be captured early in the IGCC process (before the turbine) where it is concentrated and at high pressure

TDA's CO_2 Removal System Integrated with IGCC

- CO_2 removal is completed after the desulfurization system removes the H_2S and the water gas shift process removes CO and increases the CO_2 and H_2 content in the fuel gas.
- Most advanced (hot gas and warm gas) processes for removing sulfur require that the gases be cooled to 500-700ºC before the sulfur is removed.
- The particulates are removed by either scrubbing (225-270ºC) or hot gas filtration using ceramic or sintered metal filter candles (at temperatures up to 500ºC).
- Therefore we are developing a sorbent capable of removing CO_2 at high temperatures (400-500ºC).
- This temperature range also allows us to use stainless steel for our reactor housing and minimizes any cooling and heating requirements.

TDA's CO_2 Capture Sorbent System



Schematic of TDA's Hot Fuel Gas Sorbent System for CO_2 Capture in an IGCC Power Plant

Potential Benefits

Environmental Benefits

- Substantially reduces green house gas emissions.
- Serves to minimize CO_2 emissions by capturing almost 95% of the CO_2 generated compared to 80-90% capture for a low temperature system.
- CO_2 is removed at high temperature, allowing work recovery from the hot CO_2 gas.
- TDA's high temperature CO_2 removal system increases the amount of fuel needed to generate a kWh of electricity by only 8%, while conventional systems increase the heat rate by 24%.
- Better economics for CO_2 capture in IGCC systems and would hasten the use of CO_2 capture in new power plants

Benefits to the Industrial Hydrogen Manufacturing

- The use of TDA's CO_2 removal sorbent in combination with the Water-Gas Shift (WGS) catalyst will remove the Equilibrium Limit due to constant absorption of CO_2 as it is formed.
- It would allow operation of WGS reactor at higher temperatures, which will improve the catalytic performance and per pass conversion.
- TDA's sorbent-based process can combine at least three unit operations, high temperature WGS, low temperature WGS and CO_2 removal into a single step, eliminating the energy-intensive amine separation, while producing high purity hydrogen.

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